Medical Universiti "Prof. Dr. Paraskev Stoyanov"-Varna

Faculty of Dental Medicine

Dental material science and Prosthetic dental medicine

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STUDIES ON THE CHANGES OCCURRING IN SPEECH AND MASTICATORY FUNCTIONS DURING PROSTHETIC TREATMENT

THESIS SUMMARY

of a PhD Thesis

For awarding the educational and scientific degree "Philosophy Doctor"

Scientific Specialty Prosthetic dentistry

ACADEMIC ADVISORS:

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The thesis comprises 183 standard pages and is illustrated with 32 tables, 61 figures, and includes 3 appendices. It cites 249 literary sources, 15 in Cyrillic and 234 in Latin script. The numbering of the tables and figures in the abstract does not correspond to those in the thesis.

The thesis has been approved for public defence by the departmental council of the Department of Dental material science and Prosthetic dental medicine on 19th of Martch 2024

The official defence of the thesis will take place on 19th of June 2024 in Auditorium 103 "Assoc. Prof. Dr. Dimitar Klisarov" at the Faculty of Dental Medicine, Medical University "Prof. Dr. Paraskev Stoyanov" – Varna, during a session of the scientific jury.

The materials for the defense are available at the Scientific Department of MU-Varna and have been published on the MU-Varna website.

Contents

Abbreviations

SF	**Speech function**
CI	**Confidence interval**
MF	**Masticatory function**
LP	**Laringeal pathology**
MD	**Maxillary diastema**
PT	**Prosthetic treatment**
TMC	**Temporomandibular Joint**
ENT	**Otorhinolaryngology**

Introduction

Every prosthetic construction aiming to restore single and/or multiple defects in the oral cavity affects to varying degrees the masticatory and speech function and, depending on its placement, the aesthetic appearance of the patients. The success and prognosis of prosthetic restoration depend on proper planning and precise implementation of dental treatment. The increasing popularity of digital dentistry attracts many patients seeking biological and aesthetic materials and a small number of visits to the treating dentist. The results obtained from treatments conducted according to modern protocols largely satisfy both practicing specialists and ensure the maintenance of optimal functionality of patients' teeth. Masticatory function is a key factor in ensuring the systemic, cognitive, and physical functions of the body. Unrestored defects in the dental arches disrupt masticatory function to varying degrees and can lead to malnutrition, due to limited consumption of macronutrients with a certain consistency, or to increased intake of highly refined foods, poor in nutrients and with very high energy content, but easy to chew and swallow. It is through this mechanism that defects in the dental arches negatively affect the overall condition of the body." On the other hand, the proper functioning of the organs of the masticatory apparatus enables proper speech articulation. A person's ability for verbal communication is crucial for their social belonging and for their fulfillment in life. All anatomical structures of the oral cavity, governed by the central nervous system, participate in speech formation. Through the vibration of the vocal cords, sound is produced as air moves from the lungs to the trachea and glottis. The static (teeth and hard palate) and dynamic (lips and tongue) structures of the speech apparatus further amplify and modify the sound, transforming it into speech. Disruptions in the structural integrity of tooth crowns and defects in the dental arches have a negative effect on sound articulation, as they are a passive speech organ. The beauty of the dentition is another key factor for the overall aesthetic perception of the human face and the individual as a whole. In contemporary society, there

is an increasingly strong link observed between a person's aesthetic appearance and their social status within society. The aforementioned points define the high medical-biological and preventive qualities of precisely planned and executed dental prosthetic treatment. All of this necessitates the need for modern research into the impact of prosthetics on the functions of the masticatory and speech apparatus, as well as the aesthetic appearance of the dentition. The topic of food chewing quality and the formation of the food bolus, as well as the proper formation of speech, is relevant and determinant for the success of any prosthetic treatment. All of this justifies the development of the present Phd Thesis.

OBJECTIVE AND TASKS

Objective

The aim of the present dissertation is to investigate the changes occurring in speech and masticatory function following prosthetic treatment of single frontal maxillary defects.

Tasks

To achieve our goal, we have set the following tasks:

1. To conduct an otolaryngological screening to select patients without pathology in the vocal cords.
2. To perform a retrospective study on the epidemiology of Maxillary diastema (MD) among patients from Northeastern Bulgaria.
3. To conduct a speech therapy assessment of patients with single frontal maxillary defects.

3.1. Primary speech therapy assessment prior to prosthetic treatment.

3.2. Secondary speech therapy assessment after prosthetic treatment

4. To analyze masticatory efficiency after prosthetic treatment using subjective methods.

MATHERIAL AND METHODS

For the execution of the current dissertation work, in the period from April 2022 to July 2023, clinical, experimental, and sociological research on masticatory and speech function was conducted. A total of 731 observational units were investigated, of which 80 individuals requiring prosthetic treatment (PT) with fixed constructions for single frontal maxillary defects and temporomandibular disorders (TMD) were included in the clinical group (first and third tasks). For the purposes of the second task, 149 diagnostic models were examined. In the sociological study for the fourth task, 462 patients who had undergone prosthetic treatment in the upper jaw participated. All participants were thoroughly informed about the possible risks and benefits, and all signed an informed consent form to participate in the scientific study. The scientific study was approved by the Ethics Committee for Scientific Research (ECSR) at the Medical University, Varna, protocol No. 116/28.04.2022. The clinical and experimental studies were conducted in Varna, at the Faculty of Dental Medicine, Department of Dental Materials Science and Prosthetic Dentistry, and at "AIPDP Dr. Dimo Nedelchev" Ltd., during the period 2020 – 2023. The sociological study was conducted through an online questionnaire and via paper-based surveys at the outpatient clinics for individual dental practice of Dr. Dimo Nedelchev and Dr. Desislava Konstantinova.

he results were recorded and processed using the following software:

- IBM SPSS Statistics Version 17;
- Microsoft Office Excel.

The following statistical methods were applied for the statistical analysis of the results of the studied parameters:

- Descriptive statistics;

- Statistical hypothesis testing for the difference between means of two dependent samples (Paired t-test);
- Pearson/Spearman correlation coefficient;
- Chi-square analysis;
- Analysis of ungrouped data;
- Cross-tabulations;
- Hypothesis testing (Fisher's exact test);
- Chi-square test;
- Kruskal-Wallis Test;
- Graphical and tabular representation of the obtained results;
- Chosen level of significance $\alpha = 0.05$.

MATERIAL AND METHODS OF TASK 1

Material of Task 1

During the period from April 2022 to July 2023, 187 patients sought specialized assistance for closing a maxillary diastema and restoring a single frontal maxillary defect in a specialized practice in Varna. The main complaints of the patients were deteriorated aesthetics and a sensation of air whistling through the defect. After thorough extra- and intraoral examinations, it was found that 122 individuals met the inclusion criteria for the study (Table 1) and were invited to participate in the clinical investigation. In the study, 80 patients with single frontal maxillary defects (41 males and 39 females) agreed to participate, with the mean age of the participant group being 49.21±2.25 (Fig.1). According to the gender distribution, 41 of the participants were male with a mean age of 50.76±2.97 years.

Table 1. Inclusion and Exclusion Criteria for Study Participants in Task 1.

Inclusion Criteria	*Exclusion Criteria*
Individuals aged between 18 and 65 years	*Individuals under 18 and over 65 years*
Presence of frontal maxillary defects and need for prosthetic treatment (PT)	*Presence of periodontal diseases*
Absence of general illnesses Individuals with infectious and viral diseases	*Individuals with infectious and viral diseases*

Липса на функционални заболявания: хипертония, диабет, исхемична болест и др.	*Individuals taking medications affecting salivary secretion*
Normal occlusion	*Xerostomia*
Absence of periodontal diseases	

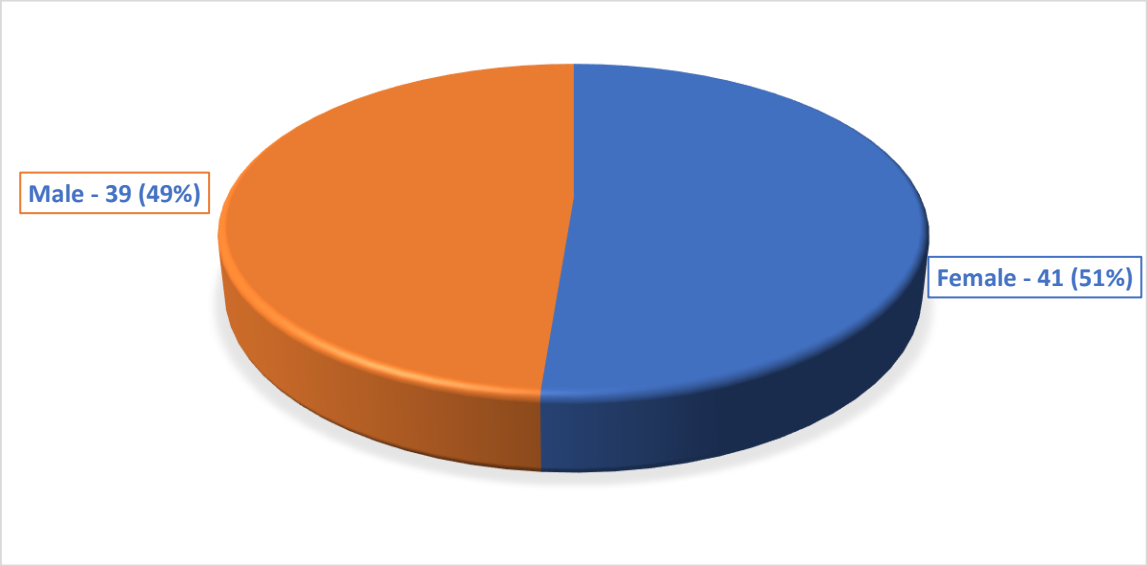


Figure 1. Distribution of the study participants in Task 1 by gender.

The studied women were 39 in number, with a mean age of 47.59±3.47 years.

All 80 patients selected for the purposes of this task were preliminarily examined extra- and intraorally by a dental medicine doctor to confirm that they met the inclusion criteria for the clinical study and to establish a comprehensive dental status. The extraoral examination included a general overview of the patients' condition, assessment of visible age compared to actual age, evaluation of overall physical condition, assessment of the type of nervous system, and examination of

the head in frontal and profile views. The intraoral examination included an assessment of the overall condition of the oral cavity, the type of occlusion, the condition of the dental arches, examination of the hard dental tissues, and the periodontium. To assess the presence or absence of periodontal pockets, as well as signs of inflammation of the gingiva and periodontium, probing of the frontal maxillary teeth was performed using a periodontal probe "UNC 15". The examinations were conducted in outpatient conditions with additional artificial lighting and a sterile dental kit. Following the dental examination, the patients underwent a laryngological screening. Prior to the otorhinolaryngological examination, a medical history form was completed. The selected participants met all the criteria for inclusion in the study and provided informed consent (Table 1).

Methods of Task 1

The patients included in the first task with single frontal maxillary defects allowed the selection of participants with proven absence of pathology in the vocal cords. An Ear, Nose, and Throat (ENT) specialist performed a comprehensive otolaryngological assessment and scoped examination of the vocal cords using laryngostroboscopy. The participants were invited to take a seated position for examination of ear, nose, and throat conditions. The patient assumed an upright position on the chair, perpendicular to the floor. The patient's head was slightly tilted backward. Using single-use gloves and sterile gauze, the patient's tongue was fixed and pulled out of the mouth. Subsequently, a digital laryngoscope was inserted, through which the image and dynamics of the vocal cords were visualized on a monitor. The data were recorded in the patient's medical history file. First, the general medical history form was completed to gather data on the overall medical condition of the patients. For the examination of the vocal cords, laryngostroboscopy was performed using the ATMOS Strobo 21 LED laryngostroboscope (Figure 2)

Figure 2. Laryngostroboscope "ATMOS Strobo 21 LED", manufacturer: Atmos, Germany.

For the purposes of the stroboscopic examination, patients were required to sing a specific vowel ("E") in a comfortable pitch for them. Through a laryngophone (microphone) connected to the stroboscope, the energy of the sound signal is electronically converted into light. In this way, the pulsed xenon lamp begins to illuminate and extinguish at the same frequency as the oscillation frequency of the vocal folds (Figure 3).

Figure 3. Stage of vocal cord examination using laryngostroboscopy.

Visual perception in the analysis of the phonatory vibrations of the glottis was performed using two mechanisms:

- A frozen, motionless image of vocal fold movement - stroboscopic comfort was the result of the ideal synchronization between the flashes of the xenon lamp and the phase of vibration of the illuminated vocal folds.
- A moving image (delayed movements of the vocal folds) - the result of the phase mismatch between the illumination and the vibrations of the vocal folds. This effect was achieved through the step regulator, actively changing the number of flashes of the pulsed lamp relative to the phonating vocal folds.

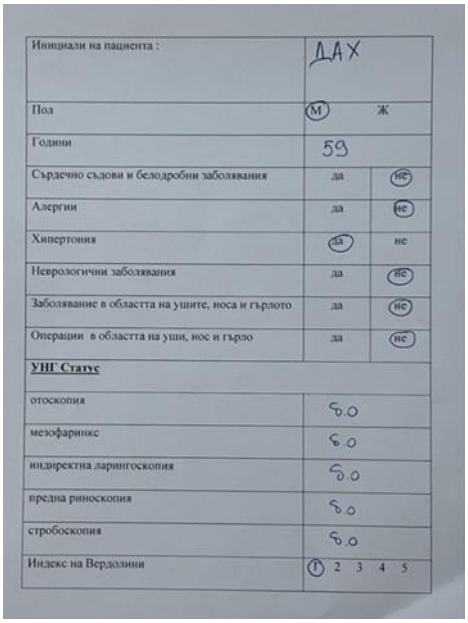
The analysis of the obtained moving image was conducted based on the following stroboscopic indicators:

- The frequency of vocal fold movement - uniform, irregular, movement of the free edge of the glottis from bottom to top, lack of vibratory mobility.
- Amplitude of oscillations - normal, increased, decreased;
- Motion pattern - equal phase of opening and closing for one vibration cycle.

The diagnosed laryngeal status was reflected in groups using Verdolini's classification:

1. Healthy larynx (without structural and functional abnormalities).
2. Mild abnormalities in the structure and function of the larynx that do not affect phonation (posterior laryngeal cleft, mild arytenoid asymmetry, slightly reduced anteroposterior size of the larynx).
3. Functional disorders of the larynx (ventricular phonation, supraglottic tension, elongated laryngeal cleft).
4. Small lesions on the vocal folds (vocal nodules, polyps, and cysts).
5. Extensive changes in laryngeal tissues (Reinke's edema, laryngitis).

The data obtained from the medical history and stroboscopic examination were recorded in a table (Figure 4).



Инициали на пациента :	ДАХ	
Пол	(М)	Ж
Години	59	
Сърдечно съдови и белодробни заболявания	да	(не)
Алергии	да	(не)
Хипертония	(да)	не
Неврологични заболявания	да	(не)
Заболяване в областта на ушите, носа и гърлото	да	(не)
Операции в областта на уши, нос и гърло	да	(не)
УНГ Статус		
отоскопия	б.о	
мезофаринкс	б.о	
индиректна ларингоскопия	б.о	
предна риноскопия	б.о	
стробоскопия	б.о	
Индекс на Вердолини	(1) 2 3 4 5	

Figure 4. Sample medical history form of a patient undergoing otorhinolaryngological screening.

For a precise analysis of the obtained results, the study group was divided into two subgroups according to age - ≤35 years and >35 years. The participants were further divided into subgroups based on gender. The information was subjected to statistical analysis using the SPSS software package, version 17. A chi-square ($\chi 2$) test for independence was conducted to examine the relationship between age and the presence of vocal fold pathologies, as well as to investigate the relationship between gender and the presence of pathological processes in the larynx. Patients with confirmed absence of pathology in the vocal folds were invited to participate in a speech therapy assessment of voice function (Task 3).

MATERIAL AND METHODS OF TASK 2

Material of Task 2

For the purposes of the second task, 149 diagnostic plaster models of patients from Northeastern Bulgaria with maxillary diastema were examined. The study of the models was retrospective. All participants included had sought dental care

due to aesthetic concerns. The diagnostic models were archived with demographic data of the patients, enabling statistical analysis based on three indicators (Figure 5).

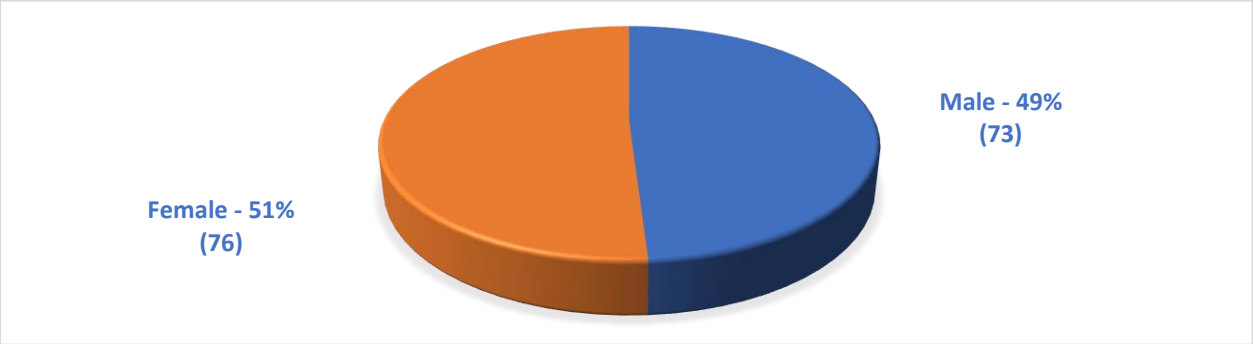


Figure 5. Graphical representation of the distribution of the examined units by gender.

The average age of all examined patients was 39.50±1.70 years. Among them, 73 of the examined models were from men with an average age of 45.64±1.92 years, and 76 of the examined models were from women with an average age of 33.59±2.04 years.

The selection of models was carried out according to the criteria for inclusion in the experimental study (Table 2).

Table 2. Criteria for inclusion and exclusion of participants for Task 2

Criteria for inclusion	*Exclusion criteria*
Models of individuals aged between 18 and 65 years.	*Models of individuals under 18 and over 65 years old.*
Presence of maxillary diastema	*Presence of periodontal desiase*
Intact frontal teeth	*Presence of erosion, attrition, and abrasion on the frontal maxillary teeth*

All plaster models were cast using Type IV dental stone, utilizing the reverse pouring method.

Methods of Task 2

To obtain relevant results for the second task, a retrospective study on the prevalence of malocclusion among the population from Northeastern Bulgaria was conducted. For this purpose, 149 diagnostic plaster models of patients meeting the inclusion criteria were selected (Table 2). The accuracy of the models depends on the accuracy of the taken impressions. Considering the retention of intact frontal teeth with a maxillary diastema, a decision was made to use condensation silicone impression material (Zeta Plus Putty and Oranwash, Zhermack, Italy). This material is widely available and has greater detail reproduction compared to alginate impression materials, as well as greater elasticity and tear strength compared to addition silicones. To neutralize the negative effect of polymerization shrinkage, the plaster models were cast within three hours of taking the impressions. The models were cast using class IV gypsum, WellsaStone IV, Wellsamed Germany, using the reverse pouring method (Figure 6). This ensured accuracy of the surfaces and sharpness of the details and provided confidence in marking the reference points.

Figure 6. Class IV gypsum, WellsaStone IV, Wellsamed Germany

For maximum precision, a digital caliper Microtech BIG SCREEN, IP54, 300 mm, 0.01 mm (fig. 7) was used, possessing calibration certificate No M2212-1941 dated 19.12.2022.

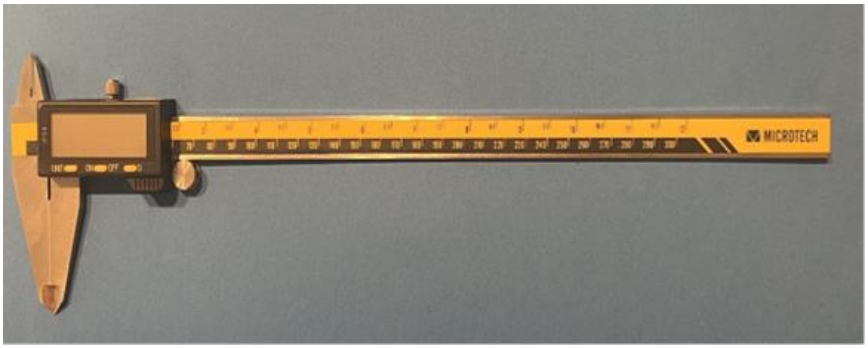


Figure 7. Microtech BIG SCREEN Digital Caliper

The examination was conducted by measuring the width of the alar base in millimeters (mm). The distance was measured between the most prominent points of the medial approximal sides of the central incisors (see Figure 8).

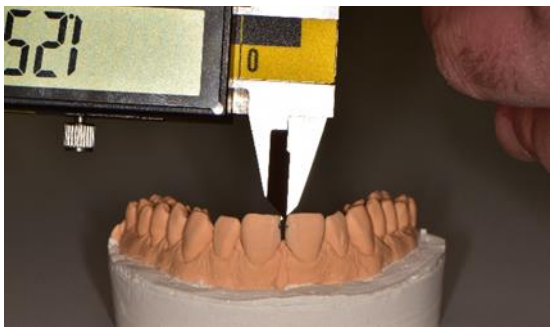


Figure 8. Measurement of the width of malocclusion in millimeters.

The mesiodistal dimensions of the frontal maxillary teeth - 13, 12, 11, 21, 22, 23 were also measured. To measure the width of the frontal teeth, the greatest distance between the mesial and distal contact points was recorded in a plane perpendicular to the longitudinal axis of the measured tooth (Figure 9).

Figure 9. Representation of measuring the mesiodistal dimension of the upper left central incisor.

To support our decision to conduct a retrospective study on plaster models, we examined the obtained data for the width of the malocclusion in 50 patients, measured intraorally (Figure 10), on plaster models (Figure 11), and on a virtual working model (Figure 12).

Figure 10. Intraoral measurement of the width of the maxillary diastema using the digital caliper Microtech BIG SCREEN.

Figure 11. Measurement of the width of the malocclusion on a plaster model using a digital caliper.

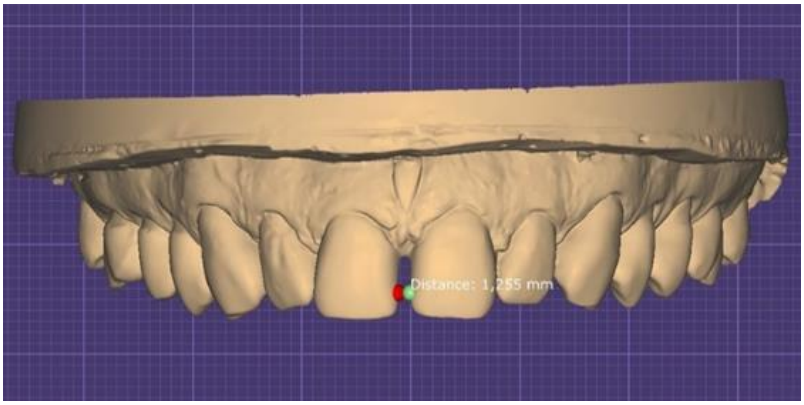


Figure 12. Measurement of the width of the malocclusion on a virtual diagnostic model. (ExoCad DentalDB 3.1 Rijeka 8349).

The obtained values for the width of the malocclusion in 50 patients, measured intraorally, on plaster models, and on digital diagnostic models, did not show a statistically significant difference (p=0.001). The lack of substantial difference in measurements, as well as the simplified workflow and reduced time for examination, argued for conducting the study on plaster diagnostic models. Due to the relatively higher average age (39.50±1.70 years), we chose to divide the examined units into two subgroups: ≤35 years and >35 years.

MATERIAL OND METHODS OF TASK 3

Material of task 3

To conduct the third task, 40 patients with single frontal maxillary defects without pathology in the vocal folds were selected for primary and secondary speech therapy assessment. The patients had an average age of 49.56±3.16 years. The examined units met the criteria for inclusion in the clinical study (Table 3).

Table 3. Criteria for inclusion and exclusion of participants for Task 3.

Criteria for inclusion	*Criteria for exclusion*
Individuals between 18 and 65 years old	*Individuals under 18 and over 65 years old*
Individuals with single frontal maxillary defects and a desire for prosthetic treatment	*Individuals with established pathology in the vocal folds*
Individuals who underwent laryngological screening without established pathology in the vocal folds	*Presence of periodontal diseases*
No pathology in the temporomandibular joint (TMJ) (arthropathies, rheumatoid arthritis, osteoporosis, osteoarthritis, traumatic arthropathy, etc.).	*Individuals with infectious and viral diseases*
No systemic diseases (hypertension, ischemic disease, diabetes, etc.)	
Angle's Class I and II occlusion	
Absence of periodontal diseases	

Methods of Task 3

For the purposes of the study, 40 observational units were selected, having undergone laryngological screening with confirmed absence of pathology in the vocal folds and presence of frontal maxillary defect (Figure 13).

Figure 13. Patient who underwent laryngological screening with confirmed absence of pathology in the vocal folds and presence of a frontal maxillary defect.

The study was conducted in three clinical and one laboratory stage. The aim of the study was to analyze the change in voice function before and after temporary restoration of single frontal maxillary defects.

In the first clinical stage, diagnostic impressions were taken from the upper and lower jaws. Standard impression trays and condensation silicone impression material in both putty and wash consistencies (Zeta Plus Putty and Oranwash, Zhermack, Italy) were used for this purpose. Отпечатъците бяха снети чрез двуетапна, двуслойна отпечатъчна техника (фиг. 14). Бяха взети и оклузални регистрати в централна оклузия, за включване в артикулатор със средни стойности.

Figure 14. Diagnostic impression of the upper jaw of a patient with maxillary diastema.

In laboratory conditions, diagnostic plaster models were cast from the taken impressions no later than three hours after impression taking. Class IV gypsum, WellsaStone IV from Wellsamed Germany, was used to fabricate the plaster models using the reverse pouring method (Figure 6). The models were made using the reverse pouring method.

All models were mounted on an articulator with average values set. Next, a diagnostic wax-up was made to plan the appropriate correction of the malocclusion and frontal maxillary defects (Figure 15).

Figure 15. Presentation of an articulator with mounted models with preliminary wax-up.

The diagnostic wax-up was performed by a dental technician using Renfert Geo Classic Snow-white Modeling Wax (Figure 16). The wax used was chosen for its medium hardness and opaque white color. These qualities aid in functional and

aesthetic planning of dental restoration. The wax-ups were performed using the incremental waxing technique, utilizing an electric waxing instrument.

Figure 16. Renfert Geo Classic Snow-white Modeling Wax, Germany

After completing the wax diagnostic wax-up, silicone keys were made on the models using condensation silicone impression material in both putty and wash consistencies (Figure 17).

Figure 17. Silicone key for transferring the wax-up onto the patient's teeth.

In the following, second clinical stage, a speech therapist conducted the primary speech assessment of patients with single frontal maxillary defects. Previously, a special technique was developed for the most accurate acoustic assessment (auditory method) to register the disturbances in sound articulation in Bulgarian speech. The pronunciation of individual sounds was assessed in isolation, in syllables, in words, in sentences, and in spontaneous speech (Figure 18). The obtained results were recorded in a special speech therapy chart for the primary speech assessment.

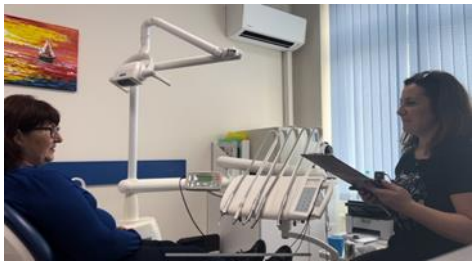


Figure 18. Working stage of determining the primary speech assessment.

Through self-polymerizing plastic Protemp 4, 3M (Figure 19), direct temporary crowns were made and the wax prototype of the PM was transferred into the patient's mouth using previously prepared silicone keys. Избрахме „Protemp 4“, тъй като не предизвиква екзотермичка реакция при неговата полимеризация и не крие риск от необратимо увреждане на зъбните тъкани на изследваните пациенти. Освен това смесването на материала с изтласкващ пистолет и смесителна канюла позволи скъсяване на клиничното време и намаляване на дискомфорта на пациентите по време на клиничното проучване.

Figure 19. Self-polymerizing plastic Protemp 4, 3M, Germany

After injecting the self-polymerizing plastic into the oral cavity, it was allowed to set for five minutes until fully hardened. Subsequently, the silicone key was removed, and the condition of the temporary restoration was assessed. The diagnostic restoration was adjusted and refined to ensure it did not interfere with occlusion and articulation (Figure 20, Figure 21). For this purpose, polishing discs and low-abrasive rubbers were used, which do not damage the tooth enamel.

Figure 20. Photograph of patient E.Z., 24 years old, in facial view with transferred wax-up.

Figure 21. Photograph of the same patient E.Z., 24 years old, in facial view with transferred wax-up.

After the finalization and adjustment of the temporary restorations, a secondary speech therapy assessment was conducted (Figure 22). The assessment stages were repeated under the guidance of the speech therapy specialist, and all data were recorded in a special speech therapy assessment chart for secondary evaluation. The chart was developed according to the specifics of our study to obtain reliable results. The chart for primary and secondary speech therapy assessment to track changes in the sound articulation of Bulgarian speech before and after restoration of single frontal maxillary defects is based on the speech therapy assessment chart developed and published in Regulation No. 6 of August 19, 2002, in the State Gazette. For the purposes of the study, a portion of the chart was used, focusing on the assessment of sound articulation. The main principle

for selecting sounds in the speech therapy chart was based on the manner in which the sound is articulated and phonologically categorized. The selection principle of the speech material was in accordance with the sequence in the chart.

Figure 22. Work stage of determining the secondary speech therapy assessment.

After completing the study, the temporary restorations were removed from the patients' teeth. The transfer of the diagnostic wax-up was performed without preparation of hard dental tissues and did not have a negative impact on the oral health of the subjects. The study group was divided into subgroups based on gender and age. Due to the higher mean age of the study subjects (49.56 ± 3.16 years), a decision was made to divide them into age groups: ≤50 years and >50 years. To assess the influence of daily speaking hours, patients in the clinical study were divided into two groups: those speaking ≤ 4 hours per day and those speaking >4 hours per day.

MATERIAL AND METHODS OF TASK 4

Material of Task 4

In the period 2020-2023, a survey was conducted among 462 patients who PT and met the criteria for inclusion in the survey. The subjects had a mean age of 57.07 ± 1.00 years. Slightly over half (238) were male. The mean age of the males

was 55.68 ± 1.28 years. The surveyed females were 224 with a mean age of 58.54 ± 1.53 years (Fig. 23)

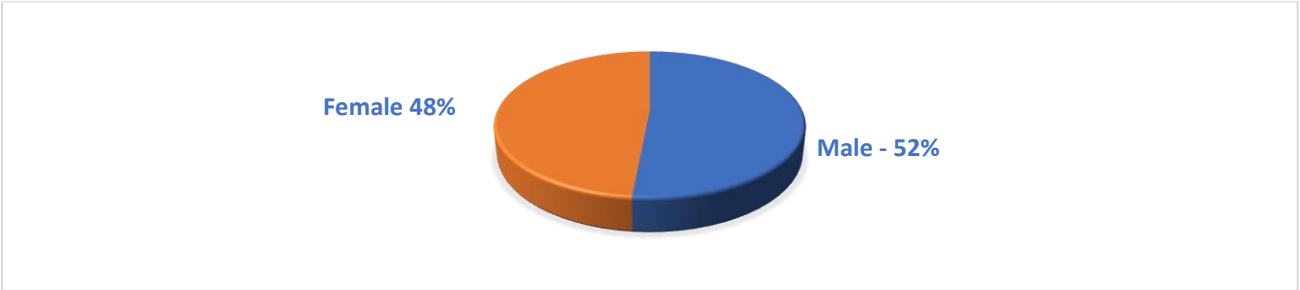


Figure 23. Distribution of the surveyed individuals in task 4 by gender.

The surveyed individuals met the criteria for inclusion in the questionnaire survey (Table 4).

Table 4. Criteria for inclusion and exclusion of surveyed individuals in task 4.

Inclusion Criteria	***Exclusion Criteria***
Individuals between 18 and 65 years of age.	*Individuals under 18 years of age and over 65 years of age.*
Patients who underwent fixed and removable PT in the upper jaw.	*Individuals without the need for PT.*
Intact antagonists	*Individuals in need of PL*
Individuals who have completed an adaptation period of two months after the placement of the prosthetic construction and have undergone a minimum of three..	*Лица с активна пародонтална патология*
Individuals with a maximum of five years since the prosthetic treatment was performed at the time of completing the questionnaire.	
Good overall health.	
Absence of regular medication intake.	

For a more precise analysis of the surveyed patients who underwent PL, the study group was divided into two subgroups: ≤ 50 years old and > 50 years old (with a mean age of 57 ± 1.00 years). According to this criterion, 66% of the surveyed patients are over 50 years old, while 24% are under 50 years old. Of all surveyed individuals, 28.4% (131 individuals) have a fixed prosthesis in the upper jaw. Partial plaque and skeletal partial dentures are present in 119 individuals (25.8%) and 97 individuals (21.0%) respectively among the surveyed. The relative proportion of surveyed individuals with upper total dentures is 24.9% (115 individuals) (Fig. 24).

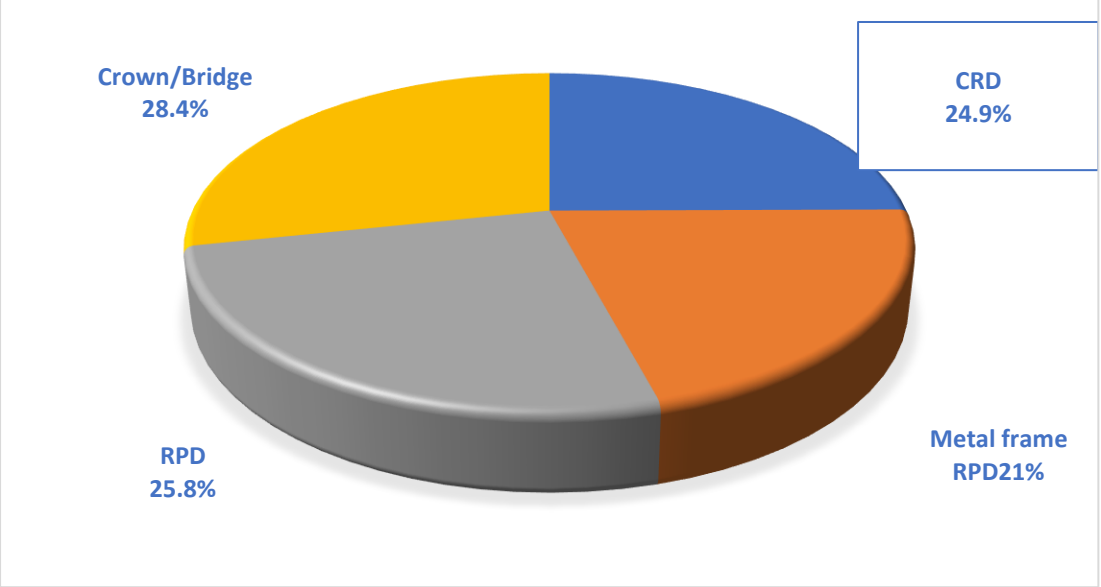


Figure 4. Percentage distribution of surveyed patients according to the type of prosthetic construction.

The patients were included in the questionnaire survey on a voluntary basis. For the reliability of the answers, we relied on the conscientious attitude of the participants.

Methods of task 4

For the purposes of the questionnaire survey, a validated, statistically significant questionnaire was used. Through 17 questions, data were collected from patients who underwent PT in the upper jaw. The analysis of the data from the collected detailed information allowed for the determination of masticatory efficiency in patients prosthetically rehabilitated with fixed constructions, acrylic and metal framed partial dentures, as well as in patients rehabilitated with total dentures. The first four questions of the questionnaire focus on a general assessment of the stages of biting, chewing, swallowing, and preferred food consistency. Questions from #5 to #7 specify differences in chewing patterns and their relationship with the comfort of prosthetic constructions. Questions from #8 to #17 encompass various aspects of macro- and micronutrient intake by the body and allow for a comprehensive assessment of food intake, the need for their preparation prior to consumption, and the influence of chewing ability on the choice of an individual diet for the patient. For the accuracy of the answers, we relied on the goodwill of the participants. The statistical analysis was conducted using a package of software applications, version SPSS Statistics 17.0 (Release 17.0.0 - 23.08.2008). The following statistical methods were used:

- Cross-tabulations;
- Hypothesis testing (Fisher’s exact test);
- Chi-square test;
- Kruskal-Wallis Test."

RESULTS AND ANALYSIS

Results and analysis of task 1

От направените изследвания се установява, че 80% (64 души) от изследваните пациенти нямат патологични изменения в ларинкса. Следователно, ако се констатират нарушения в говора, те се считат за следствие на дефекти в устната кухина. Според нозологичните единици, слаби нарушения. които не оказват влияние върху гласовата функция се наблюдават при 6.3% (5 души) от изследваните лица. Функционални нарушения на ларинкса се откриха при шестима от изследваните или 7.5 %. Малки лезии като полипи и нодули се диагностицират при един от тестваните лица – 1%. Промяна в ларингеалните тъкани вследствие на ларингит се диагностицира при четирима от изследваните или 5% от общия брой изследвани лица (фиг. 25).

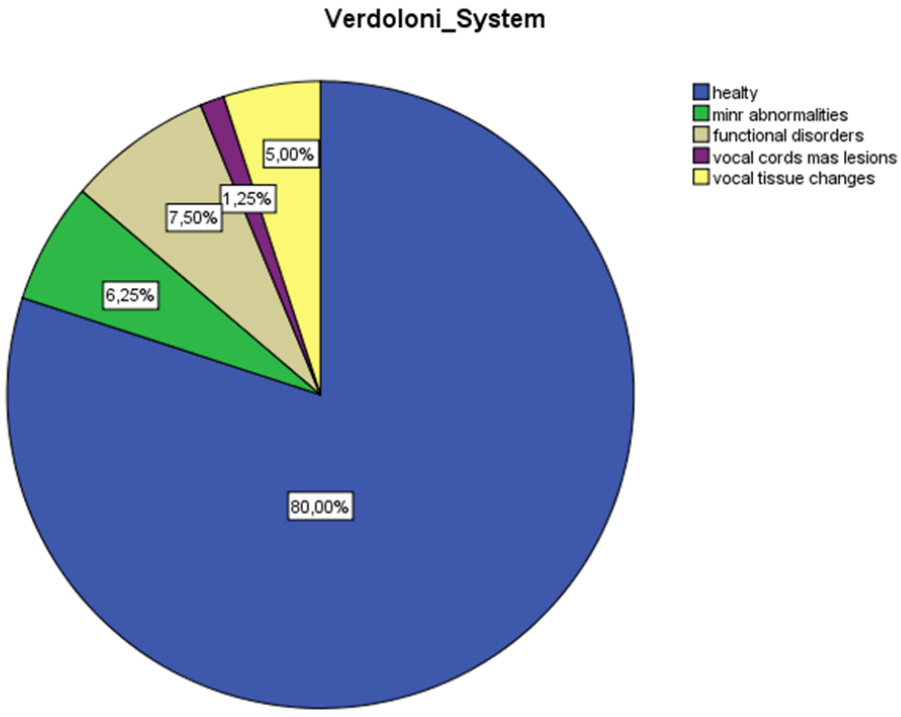


Figure 25. Graphical presentation of the distribution of vocal parameters in the examined individuals according to the Verdolini system.

When examining the distribution of vocal parameters between the two genders, no statistical difference was observed (p=0.991, α = 0.05). Among males, 80.5% (33 individuals) were found to have no pathology in the vocal folds, compared to 79.5% (31 individuals) among females. Minor structural abnormalities in the larynx were observed in 7.5% (three individuals) of the examined males and 5.1% (two individuals) of the examined females. Functional disturbances of the larynx were observed approximately twice as frequently in males – 9.8% (four individuals) compared to females – 5.1% (two individuals). Small lesions on the vocal folds were found only in one of the examined females (2.6%). Generalized tissue changes in the larynx were observed in 2.4% (one patient) of males and 7.7% (three individuals) of females (Figure 26).

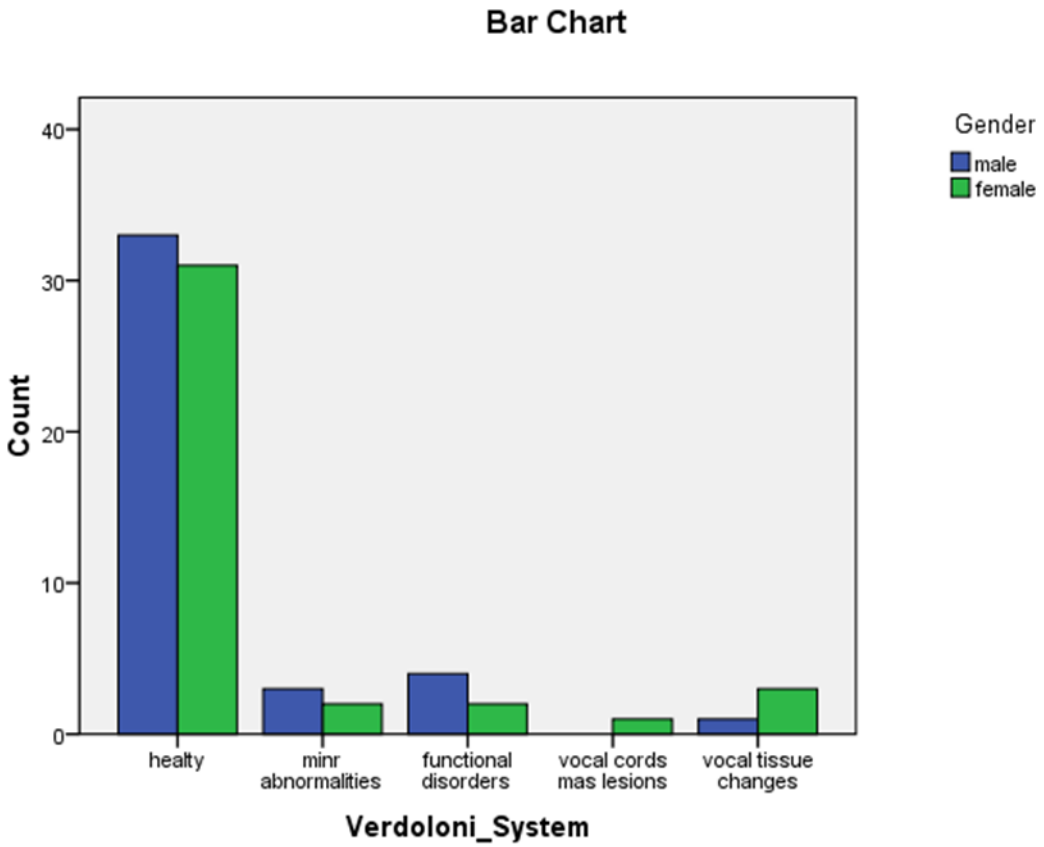


Figure 27. Relationship between gender and presence of vocal pathology.

A statistical analysis of independence was conducted using a chi-square ($\chi 2$) test to examine the relationship between gender and vocal pathology. The hypotheses that gender influences vocal pathology and that gender is not a significant factor for the presence of vocal pathology were considered. Based on the conducted test, a p-value of $p=0.911$ and $\alpha = 0.05$ was obtained. Since $p > \alpha$, it indicates that there is no statistically significant relationship between gender and the prevalence of vocal pathology. This means that gender does not appear to be a significant factor in vocal pathology as there is no statistical association between them.

The relationship between the age of the studied patients and the presence of vocal pathology was also investigated. (Figure 28)

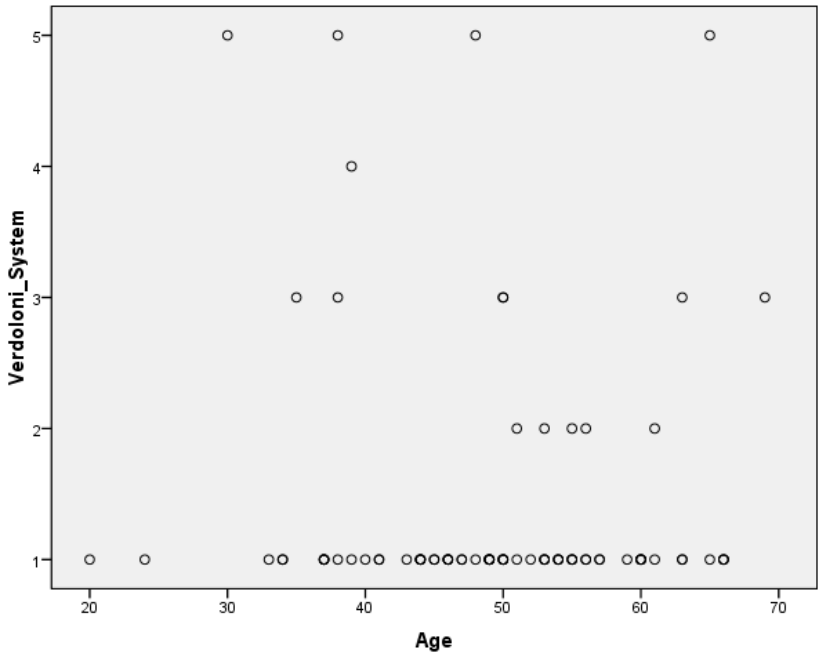


Figure 28. Correlogram depicting the relationship between age and vocal pathology.

An analysis of the data from the correlogram presented in Figure 28 shows that there is no statistical dependency between the two variables. There is no statistically significant relationship between age and the presence of vocal pathology. For a more detailed analysis of the distribution of vocal pathology,

descriptive statistics were conducted based on the age groups of the studied patients, divided into those younger or older than 35 years.

It is noted that 9% (7 individuals) of the studied subjects are aged ≤35 years. Among them, 71.4% show no pathological changes in the larynx. Pathological changes were detected in 28.6% of the studied patients in the age group ≤35 years. This indicates that at a young age, the likelihood of developing vocal pathology is low or possibly associated with other factors such as genetics, anatomy, harmful habits, etc.

Out of all the participants in the study, 91% (73 individuals) are older than 35 years of age. Various forms of pathological processes in the vocal cords were found in 19.1% (14 individuals). Pathological changes were not detected in the remaining 80.9% (59 individuals) (see Figure 29).

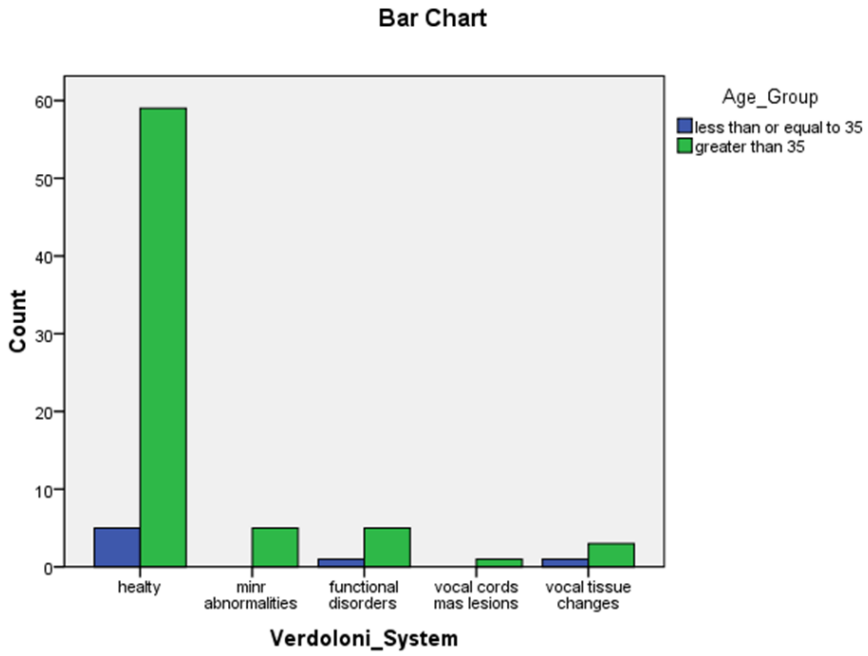


Figure 29. Graphical representation of the presence of vocal cord pathologies according to the age of the patients.

To examine the association between vocal cord pathology and the age of the patients, a chi-square ($\chi 2$) test for independence was conducted. Based on the conducted test, the p-value obtained was 0.553. At a significance level of $\alpha = 0.05$, no statistically significant association was found between age and the prevalence of vocal cord pathologies.

The analysis of the obtained results for the presence of pathological processes according to the nosological units for laryngeal pathology allows for the optimization of the classification according to Verdolini for the purposes of the current dissertation. Based on the presence of pathology affecting speech function, we summarized a scale into two degrees:

First group - absence of pathology in the vocal cords, or presence of negligible pathological processes that do not affect speech function.

Second group - presence of functional disorders, lesions, and changes in laryngeal tissue that affect speech function.

Thus, the modified classification allows for a quick determination of the etiology and potential speech impairments in Bulgarian following prosthetic rehabilitation. The patient is informed in advance and adjusts their expectations for the upcoming prosthetic laryngectomy.

After conducting statistical analysis of the study results, we found that gender is not a predisposing factor for the development of vocal fold pathology. In a similar study from 2017, Ren et al [200]. reported a higher prevalence of vocal fold pathology among the male participants compared to females. Garfinkel and colleagues also investigated the relationship between gender and the prevalence of laryngeal pathology, and their results align with those found in the current dissertation [85]. They also concluded that there is no association between gender and the presence of VFP. On the other hand, a study by Marchese et al. in 2022

reported a higher frequency of vocal fold pathology among the subgroup of female participants compared to males [159].

Similar fluctuations in results reported by different researchers are also observed in studies examining the relationship between age and the prevalence of vocal fold pathology. Although we did not find a statistically significant association between pathological changes in the larynx and the age of the studied patients, we observed a higher percentage of healthy patients in the age group ≤35 years compared to those >35 years. Similar results were reported by Van Houtte et al. in a study from 2010 [236]. The difference in results obtained by different authors is likely due to variations in the number of study participants, as well as the fact that the development of vocal fold pathology is associated with a combination of predisposing factors such as smoking, intensive use of the vocal apparatus (singers, teachers, etc.), working in dusty environments, and others.

Results and analysis of task 2

Analysis of 149 gypsum diagnostic models of patients from Northeast Bulgaria shows that they are equally distributed between both genders - men and women. The average age among men is 45.64±1.92 years, while among women it is 33.59±2.04 years. Data from the examined models show that according to gender, the mean value of the maxillary diastema (MD) size in men is 1.57±0.78 mm. The analysis of a 95% confidence interval (CI) shows that in a group of patients meeting the selection criteria for the study, with 95% certainty, the width of the MD is expected to be in the range of 1.389 to 1.754 mm. The median width of the MD in men is 1.45±0.78 mm. The smallest measured value of the MD in men is 1.09 mm, while the largest is 7.88 mm. The range of variation in the data among men is 6.79±0.782 mm (Table 5).

The analysis of the results in women shows a mean value of MD of 1.43±0.24 mm with a 95% confidence interval of 1.377 to 1.487 mm. The median width of

MD in women is 1.41±0.24 mm, which indicates an exceptional proximity to the value obtained in men. The smallest measured MD value in women is 1.05 mm, while the largest is 2.34 mm. The range of variation in the data among women is 1.29 mm. The obtained standard errors are negligibly small, ensuring the reliability of the results and allowing the conclusion that at the lower limit, the measured MD widths in both genders are very close (men – 1.389 mm; women – 1.377 mm). The upper limit value shows a more significant difference of nearly 0.3 mm, which may affect the patient's aesthetic appearance and speech function. The values of the median in men and women are extremely close (men – 1.45 mm; women – 1.41 mm) (Table 5).

Table 5. Distribution of MD according to gender.

Descriptives

	Gender			Statistic	Std. Error
Diastema	male	Mean		1,5722	,09155
		95% Confidence Interval for Mean	Lower Bound	1,3897	
			Upper Bound	1,7547	
		5% Trimmed Mean		1,4774	
		Median		1,4500	
		Variance		,612	
		Std. Deviation		,78220	
		Minimum		1,09	
		Maximum		7,88	
		Range		6,79	
		Interquartile Range		,28	
		Skewness		7,484	,281
		Kurtosis		60,745	,555
	female	Mean		1,4322	,02757
		95% Confidence Interval for Mean	Lower Bound	1,3773	
			Upper Bound	1,4872	
		5% Trimmed Mean		1,4141	
		Median		1,4100	
		Variance		,058	
		Std. Deviation		,24031	
		Minimum		1,05	
		Maximum		2,34	
		Range		1,29	
		Interquartile Range		,28	
		Skewness		1,320	,276
		Kurtosis		2,901	,545

In the box plot, an almost symmetrical distribution of MD is observed in both genders (Fig. 30). There are also several weak extreme values at the higher levels and one very high extreme value. From the obtained results, we can summarize that MD is almost symmetrically distributed in both genders. The average size of MD in the female study group is smaller than that in the male study group.

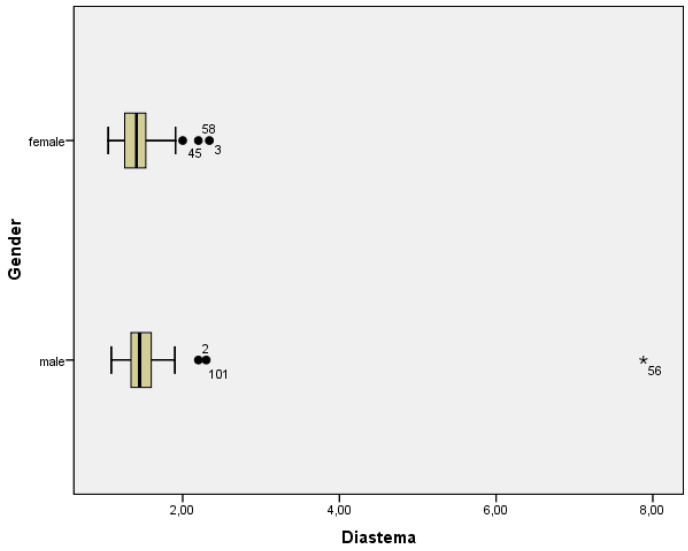


Figure 30. Graphical representation of the distribution of MD relative to gender and diastema diameter.

For the purposes of the study, the subjects were divided into two age groups. The first age group comprised individuals aged 35 years or younger. The second group included individuals over 35 years of age. Analysis of the data showed that in individuals ≤ 35 years old, the average width of the MD was 1.438 ± 0.24 mm with a 95% CI of 1.376 to 1.500 mm. The 95% CI indicates the distribution of MD width across the entire population of patients meeting the inclusion and exclusion criteria for the study in Northeast Bulgaria. It allows us to state that the width of the MD is at least 1.376 mm and at most 1.500 mm. The median width of the MD in the study group was 1.41 ± 0.24 mm. The smallest measured width of the MD in individuals ≤ 35 years old was 1.07 mm, while the largest was 2.2 mm. In individuals >35 years old, the average width of the MD was 1.544 ± 0.72

mm with a 95% CI of 1.391 to 1.696 mm. The median width of the MD in the study group was 1.44 ± 0.72 mm. The smallest measured width of the MD in individuals >35 years old was 1.05 mm, while the largest was 7.88 mm (Table 6).

Table 6. Distribution of MD in age groups ≤ 35 years and >35 years.

Descriptives

	Age_Group			Statistic	Std. Error
Diastema	equal or less than 35	Mean		1,4384	,03108
		95% Confidence Interval for Mean	Lower Bound	1,3762	
			Upper Bound	1,5005	
		5% Trimmed Mean		1,4195	
		Median		1,4100	
		Variance		,059	
		Std. Deviation		,24276	
		Minimum		1,07	
		Maximum		2,20	
		Range		1,13	
		Interquartile Range		,26	
		Skewness		1,233	,306
		Kurtosis		2,040	,604
	grater than 35	Mean		1,5441	,07681
		95% Confidence Interval for Mean	Lower Bound	1,3914	
			Upper Bound	1,6968	
		5% Trimmed Mean		1,4636	
		Median		1,4400	
		Variance		,519	
		Std. Deviation		,72059	
		Minimum		1,05	
		Maximum		7,88	
		Range		6,83	
		Interquartile Range		,26	
		Skewness		7,999	,257
		Kurtosis		70,553	,508

The obtained standard errors are negligibly small, ensuring the reliability of the results and allowing the conclusion that at the lower bounds, the measured width of the MD in both age groups is very close (≤ 35 years - 1.376 mm; >35 years - 1.391 mm). The difference in the upper bounds is more significant, approximately 0.2 mm, which may affect the aesthetic appearance of the patients and their speech function. The median values for patients ≤ 35 years (1.41 mm) and >35 years (1.45 mm) are extremely close.

There is an almost symmetric distribution of MD in both groups (≤35 years and >35 years). Several weak extreme values are observed at the high levels, along

with one very high extreme value. This suggests that patients with a large MD width are more of an exception in the studied population rather than a regularity (Figure 31).

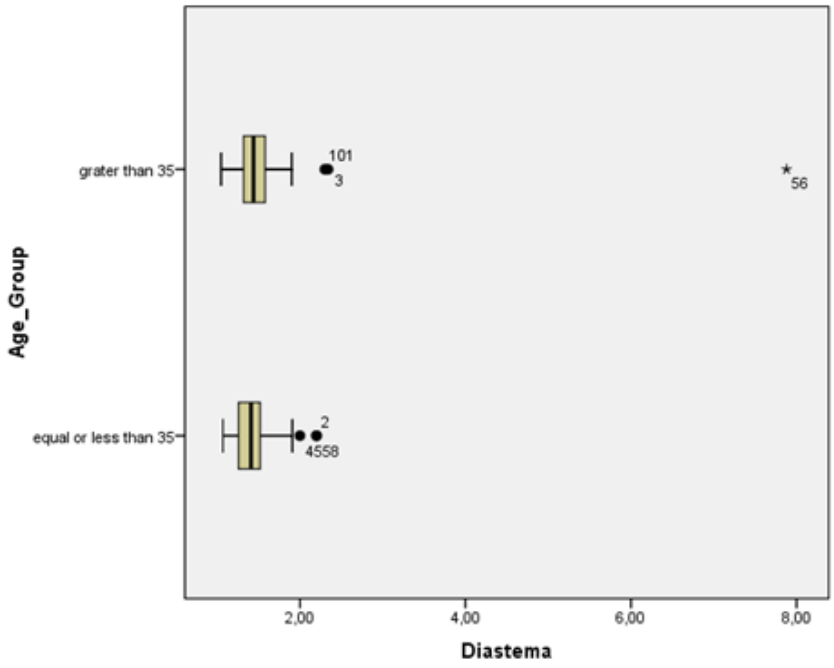


Figure 31. Graphical representation of the distribution of MD in age groups ≤ 35 years and >35 years.

Graphical analysis of the data allows visualization of the dispersion of extreme values relative to the normal distribution. Several extreme values are also observed at the higher levels (Figure 32, Figure 33).

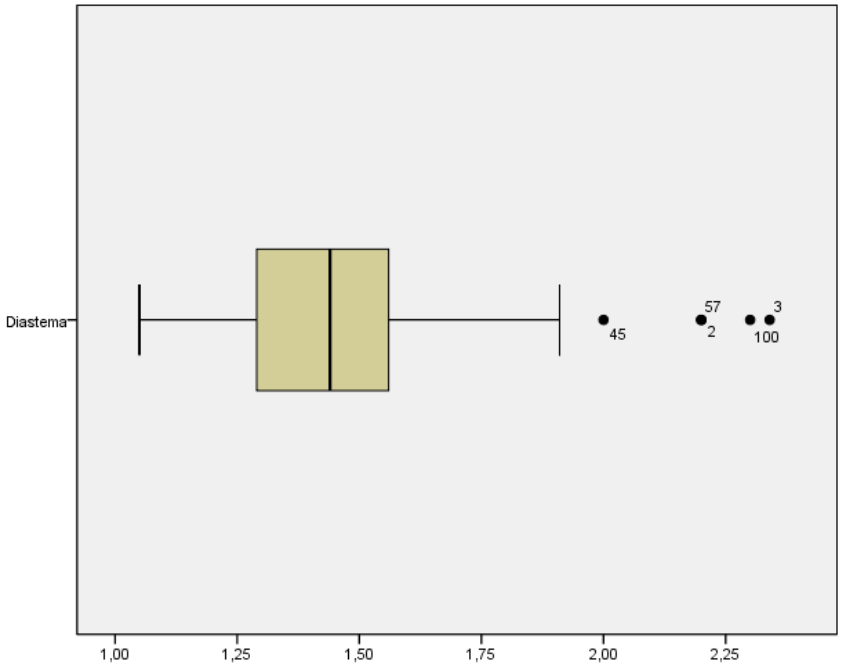


Figure 32. Representation of the frequency distribution of MD, relative to its width.

It is noteworthy that in the studied group of patients, the values of the width of the MD vary within very close limits.

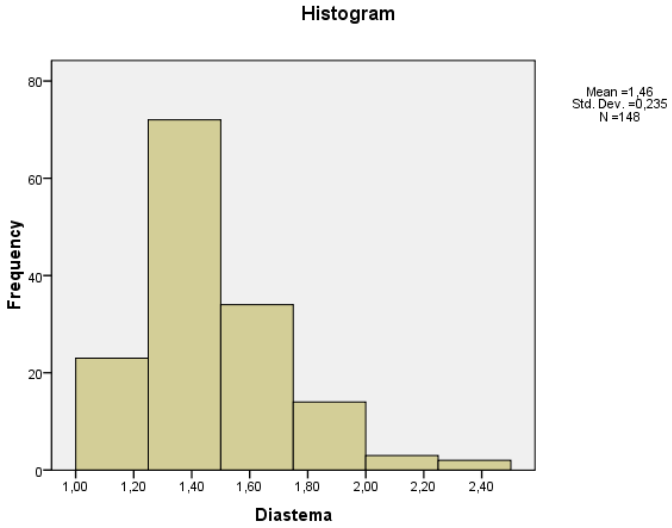


Figure 33. Representation of the frequency distribution of MD, according to its width.

Out of the 149 individuals studied, a median value of 1.46±0.23 mm was observed for the MD. The lowest frequency of distribution is observed in patients with an MD size of 2.25 mm – 2.45 mm. The highest frequency of distribution of MD is observed in patients with an MD size of 1.25 mm – 1.45 mm.

With p=0.177, no statistically significant difference in the width of the diastema is found between the studied groups of men and women at a significance level of α=0.05 (Table 13). Gender is not a statistically significant factor for the distribution of the MD.

At the two-tailed critical value of p=0.404 and a significance level of α=0.05, no statistically significant difference in the size of the MD is observed between age groups - ≤ 35 and > 35 years old. It is established that there is no linear relationship between the age of the studied individuals and the size of the MD.

Similar results are also indicated by Sękowska and Chałas [218] in their study from 2017. Several researchers analyze the distribution of MD and report varying results. This is due to the fact that the epidemiology of MD is directly related to the ethnicity, race, and age of the studied individuals.

Results and analysis of task 3

The dynamic nature of the articulation process in connected speech does not allow for an accurate assessment of the degree of speech disturbances. The most reliable assessment of the phonetic quality of sounds is obtained by studying the speech of monosyllabic and disyllabic words containing critical consonant sounds in initial position.

Due to this reason, the development of a special methodology was necessary to register the distorted consonants leading to incorrect pronunciation of words in the Bulgarian language.

In the study, the data of 40 patients were processed and analyzed in the clinical investigation. For each of them, 60 speech therapy indicators were evaluated during the primary and secondary speech therapy assessment. They were assessed before temporary correction of frontal maxillary defects (Fig. 34)

Figure 34. Presentation of patient S.S., 37 years old, with a single frontal maxillary defect, before conducting the primary speech therapy assessment.

The same indicators were evaluated after the fabrication, adjustment, and fixation of the mock-up with prognostic value (Fig. 35)

Figure 35. Presentation of patient S.S., 37 years old, with a single frontal maxillary defect, before conducting the secondary speech therapy assessment.

In 21 out of the total of 60 indicators from the speech therapy assessment, there is no distortion in the patients 'before', i.e., no treatment is required to improve sound articulation, as there is no indication of distortion of these sounds. For this reason, this is not the subject of study in the current dissertation work. It is

noticeable that the pronunciation of the sounds “V”, “F”, “D”, and “T”, as well as syllables with the same sounds, does not change the sound articulation after closing the maxillary defect. It is noted that words with the sound “Sht”, as well as the pronunciation of short sentences with the same sound, also remain unchanged after correction of the diastema. In spontaneous speech, compared to the entire pronunciation of words in the Bulgarian language, only the consonants “V”, “T”, and “D” do not undergo changes.

In another 30 out of the analyzed total of 60 indicators from the speech therapy assessment, the proportion of patients with distortion decreases before and after prosthetic correction of the frontal maxillary defect. A difference is noted ranging from 2.5% (sound “Sh”, “L”), 5% (sound “Z”, “S”, and “Zh”) to 10% (sound “Ts”`) in the distortion of the sounds.

It is noted that an equal proportion of patients exhibit distortion before and after prosthetic intervention in 8 out of all examined parameters of the speech therapy assessment.

Only in 1 of the parameters from the speech therapy assessment, the relative proportion of patients with impairment has increased before and after. This difference is only 2.5% (detected in one patient), which may be considered as a random error or measurement error in the study and is statistically insignificant. This could be tested for reliability by increasing the sample size in a future study.

A detailed analysis of the data from the table allows us to conclude that in slightly over three-quarters of the parameters from the speech therapy assessment (or 77%), improvement is observed after temporary correction of isolated frontal maxillary defects (Table 7).

Table 7: Change in speech therapy scores before and after repair of single frontal maxillary defects

Speech therapy score	% sound distortion (before)	% sound distortion (after)	% sound distortion (before)- % sound distortion (after)
Sound (S)	20%	15%	5%
Sound (Z)	12.5%	7.5%	5%
Sound (Sh)	2.5%	0%	2.5%
Sound (Zh)	5%	0%	5%
Sound (Tc)	20%	10%	10%
Sound (L)	35%	32.5%	2.5%
Syllables with sound (S)	25%	15%	10%
Syllables with sound (Z)	17.5%	12.5%	5%
Syllables with sound (Ts)	20%	12.5%	7.5%
Syllables with sound (Tc)	2.5%	0%	2.5%
Syllables with sound (L)	45%	40%	5%
Words with sound (S)	25%	17.5%	7.5%
Words with sound (Z)	17.5%	12.5%	5%
Words with sond (Zh)	2.5%	0%	2.5%
Words with sound (Tc)	22.5%	12.5%	10%
Words with sound (R)	15%	12.5%	2.5%

Words with sound (L)	42.5%	40%	2.5%
Sentence with sound (S)	25%	20%	5%
Sentence with sound (Zh)	2.5%	0%	2.5%
Sentence with sound (Tc)	20%	12.5%	7.5%
Sentence with sound (Tc)	2.5%	0%	2.5%
Sentence with sound (R)	15%	12.5%	2.5%
Sentence with sound (L)	45%	37.5%	7.5%
Spontaneous speech sound (F)	2.5%	0%	2.5%
Spontaneous speech sound (S)	25%	20%	5%
Spontaneous speech sound (Sh)	2.5%	0%	2.5%
Spontaneous speech sound (Zh)	5%	0%	5%
Spontaneous speech sound (Tc)	22.5%	17.5%	5%
Spontaneous speech sound (Ch)	7.5%	0%	7.5%
Spontaneous speech sound (L)	47.5%	37.5%	10%

The results show that the greatest improvement is observed in the sound articulation of alveodental consonants ("T", "D", "C", "Ch", "L").

The greatest improvement in distortion (10%) was observed when pronouncing an isolated "Ts" sound, syllables with "S" and "Ts" sounds, words with a "Ts" sound, and when pronouncing the "L" sound in spontaneous speech.

It is noteworthy that an improvement in distortion of 7.5% is observed in pronouncing syllables containing the sound "Ts", words containing the sound "S". The same improvement is observed when pronouncing the sounds "Ts" and "L" in a sentence, as well as when pronouncing the sound "Ts" in spontaneous speech. 5% improvement in distortion is observed when pronouncing the sounds "S", "Z" and "Zh" in isolation, as well as when pronouncing the sounds "Z" and "L" in a syllable.

A moderate improvement in distortion of 5% was also found in the pronunciation of the "S" sound in sentence and spontaneous speech, and in the pronunciation of the "Zh" and "Ts" sounds in spontaneous speech.

The least improvement (2.5%) in distortion was found when pronouncing the isolated sounds "Sh" and "L", when pronouncing syllables with the sound "Ch" and words containing the sounds "Zh", "R", and "L". The same improvement in sound articulation was observed when pronouncing the sounds "F" and "Sh" in spontaneous speech.

Investigation of factors influencing the improvement of sound articulation.

Assessing the impact of hours per day spent speaking on change in speech-language indicators.

Analysis of the data showed that patients in the first group, which included those who spoke four or fewer astronomical hours per day, and patients in the second group, which included those who spoke more than four hours per day, showed no

differences in terms of change in speech performance There was no statistically significant difference between the two groups (p = 0.343). That is to say, according to the factor of influence of astronomical hours per day spent in speaking, no improvement was found in Bulgarian speech.

The analysis performed using Chi-square test at α = 0.05 level of significance to specify the influence of the factor "hours per day spent in speech" showed that there was no statistically significant correlation (p = 0.344). The distribution of individuals with and without improvement after prosthetic treatment of MD showed that the relative proportion of individuals who spoke for more than four hours was 72% and those who spoke for less than four hours was 27%.

Graphical presentation of these data found no statistical relationship between hours per day spent speaking and improvement in speech therapy performance (Figure 36).

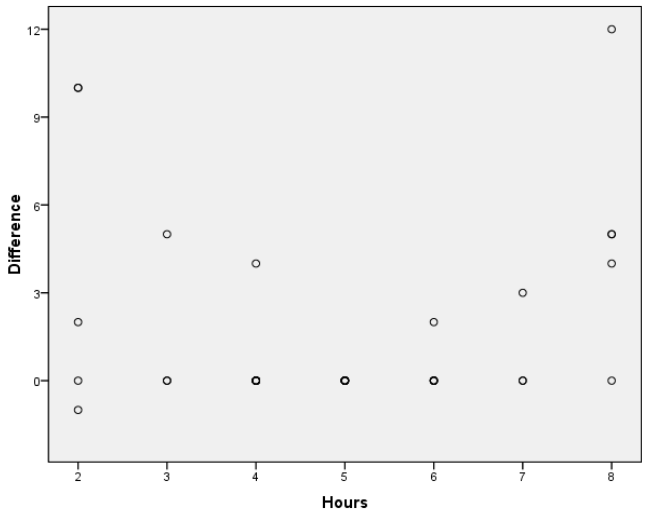


Figure 36. Representation of a graphical analysis showing a linear relationship between improvement in sound articulation and hours per day spent speaking.

Kendall's coefficients (-0.146) at p = 0.247 and Spearman's coefficients (-0.189) at p = 0.242 demonstrate that there is no relationship between hours per day spent

speaking and improvement in speech performance after recovery of single frontal maxillary defects.

Exploring the relationship between patient age and improvement in speech therapy performance.

To assess the influence of age, patients in the clinical study were divided into two subgroups. The first group consisted of patients 50 years of age and younger. The second group consisted of patients over 50 years of age (Table 8).

Table 8: Improvement of speech therapy indicators by age groups

Age_Group * Improvement Crosstabulation

			Improvement		
			No	Yes	Total
Age_Group	equal or less than 50	Count	11	6	17
		Expected Count	12,3	4,7	17,0
	greater than 50	Count	18	5	23
		Expected Count	16,7	6,3	23,0
Total		Count	29	11	40
		Expected Count	29,0	11,0	40,0

The study of the relationship between the patients' belonging to the age group less or more than 50 years and the improvement of the sound articulation after prosthetics showed that there was an inverse statistical relationship ($p = 0.343$, $\alpha = 0.05$). Patients in the age group less than 50 years had a higher incidence of improvement in sound articulation after prosthetics.

After performing a $\chi 2$ analysis, it was found that $p = 0.343$, > from a significance level of $\alpha = 0.05$. The two variables are dependent, or age influences the improvement of speech therapy performance. 35.3% of individuals under 50 years of age obtained improvement in pronunciation of sounds, while only 21.7% of individuals over 50 years of age. There were greater improvements in younger patients compared to older patients. From the correlogram, it can be hypothesized that there is a negative linear relationship between the age of the patients and the

number of improvements in the isopacitations, although a large scatter was observed (Fig. 37).

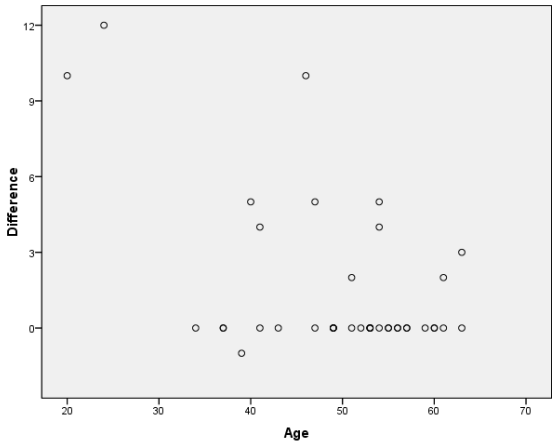


Figure 47. Presentation of the data on the linear relationship between the age of the studied patients and the improvement of speech therapy indicators.

The correlation coefficient was statistically insignificant (p = 0.001). There was a moderate negative correlation between the variables studied (P = -0.516). With increasing age, the improvements in speech performance after recovery of single frontal maxillary defects decreased.

Due to the inhomogeneity of the data, Pearson's parametric correlation coefficient was used (Table 9).

Table 9. Correlation coefficient

Correlations

		Age	Difference
Age	Pearson Correlation	1	-,516**
	Sig. (2-tailed)		,001
	N	40	40
Difference	Pearson Correlation	-,516**	1
	Sig. (2-tailed)	,001	
	N	40	40

**. Correlation is significant at the 0.01 level (2-tailed).

The correlation coefficient was statistically insignificant (p = 0.001). There was a moderate negative correlation between the variables studied (P = -0.516). With increasing age, the improvements in speech performance after recovery of single frontal maxillary defects decreased.

The mispronunciation of consonants in Bulgarian speech in patients with single frontal maxillary defects remains within the acceptable limits, i.e. the classical objective methods, in which the assessment is presented as a percentage of mispronounced sounds to the total number of pronounced sounds, cannot be used for the quantitative assessment of GF disturbances. For this reason, auditory methods conducted by a specialist speech and language therapist have proven to be more reliable and of greater clinical and diagnostic value.

Results and analysis of task 4

One of the factors for assessing the quality of masticatory function is the ability of patients to consume food of any consistency. In our study, 44.8% of the respondents indicated that they preferred food of normal consistency, 24.2% had no preference and could chew anything, and 31.0% preferred soft and liquidy food (Fig. 37).

Figure 37. Preferred consistency of food intake.

After analysing the responses to the question "Do you chew on both sides at the same time?", it was found that 44.6% of the respondents performed a normal

chewing cycle and 43.9% always ate on both sides at the same time. 11.5% of the respondents had difficulty when trying to transfer the bite from one side to the other (Fig. 38).

Figure 38. Distribution of patients surveyed, according to the possibility of a physiological masticatory cycle.

According to the chewing stereotype, almost half (48.1%) of the respondents answered that they cannot chew quickly and chew slowly. Another 27.5% often chew quickly. 13.4% always chew quickly and 11% of the respondents experience a handicap when chewing quickly (Figure 39).

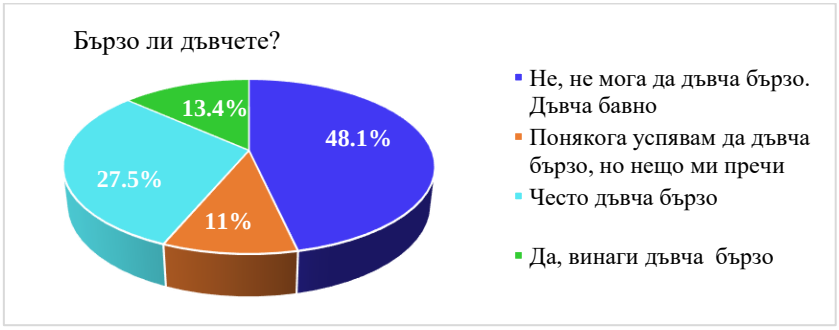


Figure 39. Distribution of respondents according to the speed of performing the act of chewing.

Meat is known to be a stringy food, yet 66.9% of individuals surveyed had no difficulty chewing small pieces of meat and almost one-fifth (18.2%) had some

difficulty. For 11.9% of respondents, chewing such food is always a difficulty and 3% cannot chew it at all (Figure 40).

Figure 40. Distribution of respondents according to ability to chew small pieces of meat.

When asked "Can you bite an apple without cutting it?", 51.1% of respondents indicated that they could bite without any problem. 27.3% of respondents could only bite an apple if it was cut into pieces. For 8.4% of respondents this is always a problem, and 13.2% of them cannot chew such food at all (Fig. 41).

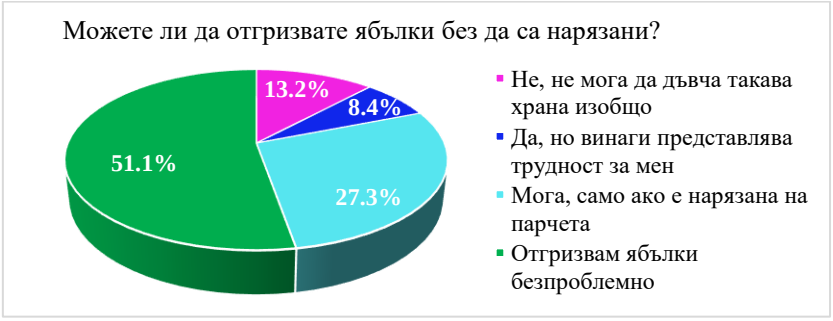


Figure 41. Distribution of the surveyed persons according to their ability to bite an apple.

After analysing the responses to the question "Do you have difficulty chewing hard raw fruit ?", it was found that almost half or 48.9% of the respondents had no difficulty chewing such food, while 31% had some difficulty. 14.7% always have difficulty in chewing hard raw fruits while 5.4% of the respondents cannot consume them at all (Fig. 42)

Figure 42. Percentage distribution of respondents according to their ability to chew hard raw fruits.

After analysing the answers to the question "Do you have to pre-cut the harder foods (meat, fruit and vegetables) into small pieces?", it was found that 40.5% of the respondents never have to do this and 31.6% of them sometimes have to pre-cut the harder food. For 13.4% of the respondents it is often necessary to pre-cut solid food, and for 14.5% of them it is a prerequisite (Figure 43).

Figure 43. Distribution of respondents according to their ability to consume more solid foods.

When analysed for the indicated responses from the question "Do you have to puree your food beforehand to take it ?", it is found that 71.9% of the respondents never prepare their food into puree beforehand. 15.2% indicated that they

sometimes have to puree their food in advance. 9.1% prepare their food in very fine pieces, while pre-puréeing is a must for 3.9% of respondents (Figure 44).

Figure 44. Percentage distribution of respondents according to their need to puree their food beforehand.

To the question "Can you chew carrots without grating them ?" 64.3% of the respondents indicated that they can do this task without any problems and 26.8% can, but it takes a lot of time and effort. 0.7% cannot eat carrots without grating them, and 8.2% cannot eat this food at all (Fig. 45).

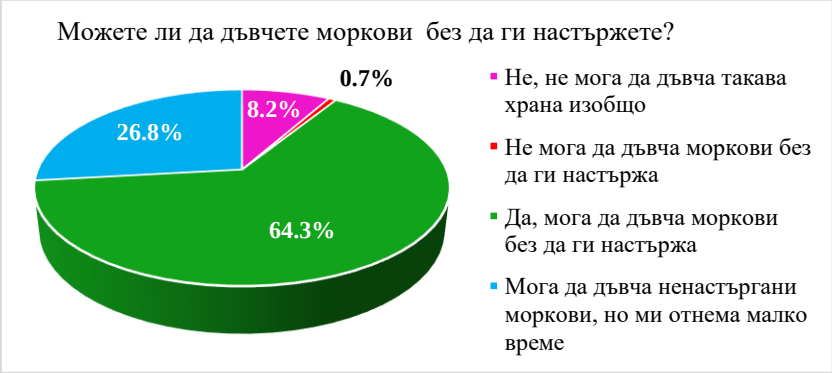


Figure 45. Distribution of respondents to consume grated carrots.

56.3% of the individuals surveyed indicated that they consume whole nuts normally. 11.9% sometimes have difficulty. This food is always a difficulty for 15.4% of the respondents, 16.5% of them cannot consume it at all (Fig. 46).

Figure 46. Percentage distribution of patients according to their ability to consume whole nuts.

When asked "Have you ever had to swallow food without chewing it completely ?", 68% of the respondents indicated that they swallowed food only when it was well chewed and 24.5% sometimes swallowed food without chewing it well. 7.5% of respondents often have to swallow their food without chewing it properly (Fig. 47).

Figure 47. Distribution of respondents according to the consistency of the food at the time of swallowing.

Respondents were asked to answer whether they had difficulty chewing bread crusts. 59.5% indicated that they chewed crusts normally, while 18.8% sometimes had difficulty. 4.8% of respondents indicated that chewing bread crusts was always a difficulty for them, while 16.9% could not chew such food at all (Figure 48).

Figure 48. Distribution of respondents according to their ability to chew bread crusts.

The study units were asked "Do you have to take liquids during meals to swallow ?". 62.2% indicated that they never have to take liquids during meals. 19% rarely take liquids during meals. The same percentage of respondents (9.1%) answered that they often take liquids and always take liquids during meals (Fig. 49)

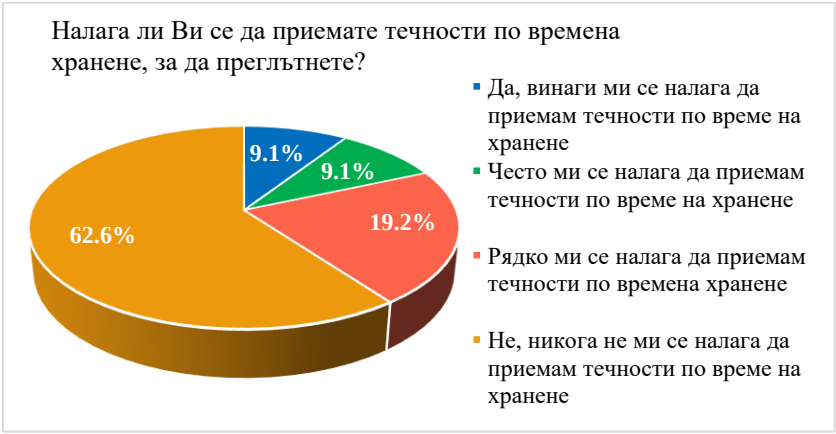


Figure 49. Distribution of respondents according to their need to take liquids during meals.

The last question of the survey was, "Do you prefer to have sauce with your food to make it easier to swallow?" 20.3% of respondents indicated that they preferred dry food. Rarely do 46.3% prefer sauce with their food. Frequent preference for sauce was indicated by 20.3%, while 11.5% of respondents always preferred sauce with their food (Figure 50).

Figure 50. Percentage distribution of respondents according to the preference for the presence of sauce with food.

After analyzing the results presented in Table 26, a higher frequency distribution of partial and full plate dentures was found in individuals over 50 years of age (28.5% and 30.7%), compared to respondents aged 50 and under (19.1% and 11%) (Table 10). Age was a significant factor for prosthesis type (α = 0.05, p-value = 0.000).

Table 10. Percentage distribution of different prosthetic designs according to the age of the respondents.

Age_group * Denture_Type Crosstabulation

			Denture_Type				Total
			FPD (fixed partial denture)	MFPD (metal frame partial denture)	RPD (removable partial denture)	CRP (complete removable denture)	
Age_group	equal or less than 50	Count	55	40	26	15	136
		% within Age_group	40,4%	29,4%	19,1%	11,0%	100,0%
	greater than 50	Count	76	57	93	100	326
		% within Age_group	23,3%	17,5%	28,5%	30,7%	100,0%
Total		Count	131	97	119	115	462
		% within Age_group	28,4%	21,0%	25,8%	24,9%	100,0%

The age of the studied patients probably influences the type of prosthodontics because of deepening senile changes and progression of pathological changes in the hard tissues of the teeth and periodontium. The combination of these factors results in the loss of a greater number of teeth and makes it impossible to provide irreducible prosthodontics by conventional methods. The higher incidence of

removable plaque constructions may also be caused by social and economic factors, as their fabrication requires less money.

Significant differences were also observed in the structure of prosthetics between men and women. For example, the relative proportion of women with bridge prosthesis constructions (35.3%) was higher compared to that of men (21.9%). On the other hand, the relative proportion of men with partial plate prostheses (36.1%) was higher compared with that of women (14.7%) (Table 11).

Table 11. Correlation between gender and prosthesis type.

Gender * Denture_Type Crosstabulation

			Denture_Type				Total
			FPD (fixed partial denture)	MFPD (metal frame partial denture)	RPD (removable partial denture)	CRP (complete removable denture)	
Gender	Male	Count	52	50	86	50	238
		% within Gender	21,8%	21,0%	36,1%	21,0%	100,0%
	Female	Count	79	47	33	65	224
		% within Gender	35,3%	21,0%	14,7%	29,0%	100,0%
Total		Count	131	97	119	115	462
		% within Gender	28,4%	21,0%	25,8%	24,9%	100,0%

Gender was a significant factor in prosthesis type ($\alpha = 0.05$, p-value = 0.000).

A number of factors may explain the results obtained. On the one hand, men are relatively more irresponsible about their dental health and visit a dental specialist more often when necessary than for routine preventive examinations. In the long term, this leads to earlier partial and complete dentition and explains the higher prevalence of removable plate dentures. Women, on the other hand, are much more responsible about preventive dental examinations and the prevention of hard tissue and periodontal disease. The combination of these factors results in the preservation of better dentition and the availability of prerequisites for treatment with non-removable prosthetic structures. Vanity and ever-increasing aesthetic demands and desires also probably explain the higher incidence of non-removable prosthetic constructions in female respondents.

Almost all of the respondents with bridge prosthesis (95.4%) and all of the respondents with model cast partial dentures (97.9%) indicated that they could eat normal and solid food. The proportion of respondents with cast partial dentures who indicated they could eat normal and solid food was just over half (52.2%). Respondents with complete plate dentures had the greatest difficulty chewing normal and solid food. Only 33.6% of them reported that they could take food of similar consistency (Table 12).

Table 12. Correlation between preferred food consistency and type of prosthetic construction

Denture_Type * Food_Consistancy Crosstabulation

			Food_Consistancy			
			Soft, Liquid mash	Normal	Hard and all of the above	Total
Denture_Type	FPD (fixed partial denture)	Count	6	60	65	131
		% within Denture_Type	4,6%	45,8%	49,6%	100,0%
	MFPD (metal frame partial denture)	Count	2	62	32	96
		% within Denture_Type	2,1%	64,6%	33,3%	100,0%
	RPD (removable partial denture)	Count	54	51	8	113
		% within Denture_Type	47,8%	45,1%	7,1%	100,0%
	CRP (complete removable denture)	Count	81	34	7	122
		% within Denture_Type	66,4%	27,9%	5,7%	100,0%
Total		Count	143	207	112	462
		% within Denture_Type	31,0%	44,8%	24,2%	100,0%

After conducting a $\chi 2$ test for independence with the variables type of prosthetic construction and preferred consistency of food intake, the two variables were found to be dependent at a significance level of $\alpha = 0.05$ and $p = 0.000$.

The results obtained can be explained by the way the masticatory pressure is transmitted during DF. Fixed bridge prosthetic constructions as well as partial skeletonized prostheses (through their occlusal arms) transmit the masticatory pressure physiologically through the periodontium of the loaded teeth. This gives patients a sense of comfort and confidence and enables them to exert greater chewing force and thus eat solid foods without difficulty. Partial plate dentures are retained by the patient's natural teeth, but chewing pressure is transmitted exclusively through the mucosal route. This drastically reduces the masticatory

force that can be applied during DF and makes it difficult to accept solid foods. Chewing pressure is transmitted by the same mechanism in the case of complete removable dentures. However, they are retained only on the basis of adhesive and cohesive forces to the soft tissues. Resting retention and stability during function are weaker for whole dentures compared with the other types of denture designs considered. This accounts for the greatest reported difficulty in consuming solid food by respondents with complete dentures.

Conclusions

1. There was no statistical correlation between the age of patients and the prevalence of those diagnosed with laryngeal pathology (p=0.553).
2. Gender is not a statistically determining factor in the development of pathological processes in the vocal cords (p=0.911).
3. Bulgarian speech is significantly affected in the presence of a dental row defect.
4. There is a symmetrical distribution of the prevalence of MD between the two sexes.
5. According to the survey of the available scientific literature in Bulgaria, the influence of removable prosthetic constructions on speech function is well studied.
6. The mean MD width in the female study group (1.43 mm ±0.24) was smaller than that in the male group (1.57 mm ±0.78).
7. Statistical correlation was found between the age of the studied patients and the width of the MD. The size of the MD increased with increasing age (Kendall = 0.123, Spearman = 1.148).
8. Improvement was found in 30 out of 60 speech-language indicators at the mockup stage, and this determined a good prognosis of the future construct for restoration of a single frontal maxillary defect.
9. There was no statistical correlation between hours per day spent speaking and speech therapy performance (p=0.972).
10. The greatest improvement in pronunciation after temporary restoration of single frontal maxillary defects was observed in alveolodental consonants (S, Ts, L).
11. An inverse statistical correlation was found between the age of the studied patients and the improvement in speech therapy indicators (p=0.343).

12. There is an orthogonal statistical correlation between the age of patients and the presence of removable dentures With increasing age, the percentage of patients with removable dentures increases (p=0.000).
13. The relative proportion of women with fixed prosthetic constructions (35.3%) is higher than that of men (21.8%).
14. The relative proportion of men with removable denturesns (36.1%) is higher than that of women (14.7%).
15. Almost all of the respondents with fixed constructions and skeletonized model-cast dentures could consume normal and hard-textured food.

Summary

The research in this thesis is motivated by the increasing functional and aesthetic demands of dental treatment. After an in-depth analysis of the existing literature on the subject, it was found that there are many consonant sounds in the Bulgarian language, the expression of which is disturbed both when a defect of the tooth row is formed and after prosthetic treatment, proven in removable dentures. Single frontal maxillary defects, including maxillary diastema, have proven to be not only an aesthetic but also a phonation problem. A major indicator of speech impairment in dental row defects (such as maxillary diastema) is the altered phonetic quality of the sounds in Bulgarian speech and their incomplete voicing, which is a natural consequence of their incomplete accommodation. The main problem for an accurate quantification of the disturbances in speech function comes down to finding a methodology to objectively measure the incompleteness of the phonetic quality of the pronounced words. Our studies have shown that at the wax up and mock up stage, a possible pronunciation disorder can be predicted for some consonants in Bulgarian. This applies most strongly to the alveolar sounds "S", "Ts" and "L". All of the available literature comments on the change in speech in the presence of untreated dental row defects or of dentures with removable structures. Our study is a pilot project that investigates a private case of fixed prosthodontics. Due to increased patient demands for maxillary diastema correction, the study also resulted in a high prevalence in the Northeast Bulgaria. The present work demonstrates the positive influence of fixed prosthetic treatment on the pronunciation of sounds in Bulgarian speech. The study of speech function is incomplete without prior instrumental diagnosis of the condition of the vocal cords. This is due to the fact that a number of pathological conditions can have a negative impact on the vocal function and thus on the pronunciation of sounds in the Bulgarian language. Our study showed that after fixed prosthetic treatment of maxillary diastema and single frontal maxillary

defect positive changes in Bulgarian speech were observed. The prediction of these changes can be done before the final completion of the recovery thanks to the preliminary modelling and thus improve the prediction of the permanent recovery. The present study also investigated the possibility of examining masticatory function in patients who have undergone prosthetic treatment. To study the functional suitability of prosthetic constructs in their entirety, it is also imperative to analyze masticatory function. Using a subjective method of examination, the best masticatory ability was found in patients prosthetized with non-removable designs as well as with model-molded partial dentures. A statistically significant relationship was also found between the age of the patients and the type of prosthesis, as well as between the sex of the respondents and the type of prosthetic design.

Contributions

1. Scientific and applied contributions

Of original nature

- For the first time in our country, a multidisciplinary comprehensive speech study including otorhinolaryngological screening, speech therapy assessment and auditory method for functional phonetic assessment in clinical settings was conducted.
- A methodology for speech therapy evaluation of patients with dental row defects before and after prosthetic treatment was developed.
- The greatest improvement after MD prosthetic restoration was demonstrated in the pronunciation of the consonants "L", "Tc", "S" and "Tc", both in spontaneous speech and in sentences with the corresponding sound.
- A retrospective epidemiological study of the prevalence of maxillary diastema in Northeastern Bulgaria was conducted for the first time.

Of a confirmatory nature

- After prosthetic treatment, with removable and fixed dentures, masticatory function and the ability for sound articulation are significantly improved.
- Using a subjective research method, the best masticatory performance was found in patients with prosthetically restored maxillary defects with non-removable constructions and with metal framed partial dentures.

2. Applied contributions

Thesis-related publications

- The classification for grouping patients with pathology in the vocal cords was modified for accessibility and ease of use in daily outpatient practice.

- It was found that there were no differences in sound articulation between patients who spent more hours per day speaking and those who did not exercise sound articulation for prolonged periods.

Thesis-related publications

Nedelchev, D. (2022). Videolaryngostroboscopy as a diagnostic method in the clinical practice of otorhinolaryngologists and physicians in dental medicine. ***International Bulletin of Otorhinolaryngology*****,** ***18*****(4), 22-24.**

Nedelchev, D., & Konstantinova, D. (2023). Epidemiology, etiology, and treatment possibilities for maxillary diastema. ***Journal of the Union of Scientists-Varna. Medicine and Ecology Series*****,** ***28*****(1).**

Nedelchev, D., & Konstantinova, D. (2024). Changes in the sound articulation of Bulgarian speech following non-removable prosthetic restoration of frontal maxillary defects. ***International Bulletin of Otorhinolaryngology*****,** ***19*****(1), 25-27.**